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On the Display Effect of Latent Sweat Fingerprints with 445nm and 532nm Laser

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ABSTRACT ***Objective*** To compare and analyze the difference in the effect of 445nm and 532nm lasers on the sweat latent fingerprints on different objects in the field survey, for reference in actual combat. ***Methods*** The 445nm and 532nm lasers were used to directly visualize the sweat latent fingerprints on white walls, white tiles, granite, and marble. The display effects of sweat latent fingerprints on different objects were compared and the reasons for the differences were analyzed. ***Results*** The difference of laser wavelength directly affects the display effect of sweat latent mudra. There are also obvious differences in the laser display effect of sweat latent mudra on different objects. This is related to the material composition and structure of the object, and the energy transfer and conversion mechanism within the object. There is a certain relationship. ***Conclusion*** According to different objects, it is necessary to select the appropriate wavelength of the laser to achieve the best display effect.

KEY WORDS Forensic science; Crime scene investigation; Laser; Sweating fingerprints; Fluorescence; Manifestation

1. INTRODUCTION

Laser technology has been widely used in the process of on-site investigation. The function of laser is to search and display traces of biological samples including sweat, blood, semen, and urine spots. In actual on-site investigation and identification of physical evidence, there are mainly two types of lasers commonly used in the visible band, one is 445nm laser, and the other is 532nm laser. However, in actual work, it is found that there are certain differences between the 445nm laser and 532nm laser in the specific application process, especially when the sweat fingerprints are displayed, due to the difference of the object, the laser shows the effect of the fingerprints are also different.

We used 445nm and 532nm lasers to directly visualize the sweat fingerprints on the indoor white walls, common white tiles, granite stone, and marble stone. The effects were compared and the differences were analyzed and discussed.

2. MATERIALS AND METHODS

2.1 Experiment equipment

The selected laser is a dual-band laser material evidence surveyor (445nm, 532nm, XS-L-MINI-G8, Suzhou Xiaosong Technology Development Co., Ltd.), and the shooting equipment is a Canon 5D Mark II SLR camera, equipped with a yellow filter and an orange filter.

The selected objects are indoor white walls, common white tiles, granite stone, and marble stone. (See Figure 1 - 4)

2.2 Experimental methods

1) Continuously press the volunteer's sweat fingerprints on the same finger at three different positions on the white wall, and repeat multiple groups with multiple people;

2) Press the same finger sweat fingerprints of the same person on the surface of the white tiles, granite stone and

marble stone objects, and repeat multiple groups for multiple persons;

3) Use a 445nm laser, use a Canon 5D Mark II SLR camera with a yellow filter and an orange filter to visualize the three fingerprints on the white wall, and then use a 532nm laser, use a Canon 5D Mark II SLR camera with an orange filter to display the hands on the white wall Printed to reveal;

4) The following methods are used to visualize the sweat fingerprints on white tiles, granite stones and marble stones: using a 445nm laser and a Canon 5D Mark II SLR camera equipped with a yellow filter; using a 532nm laser and a Canon equipped with an orange filter The 5D Mark II SLR camera appeared.

5) Compare and analyze the display effects.

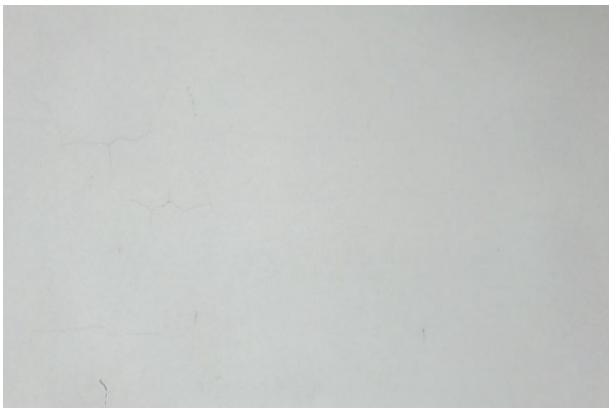


Fig. 1 The white wall

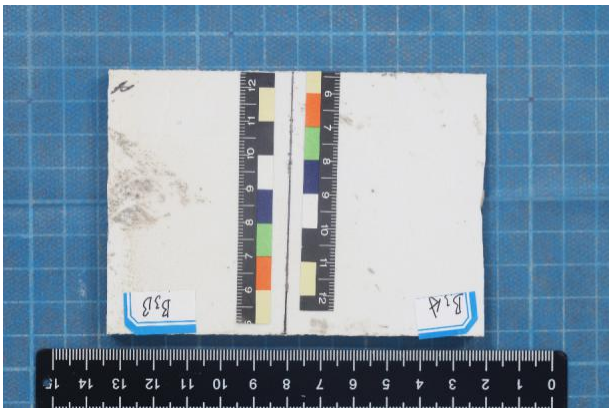


Fig. 2 The white tiles

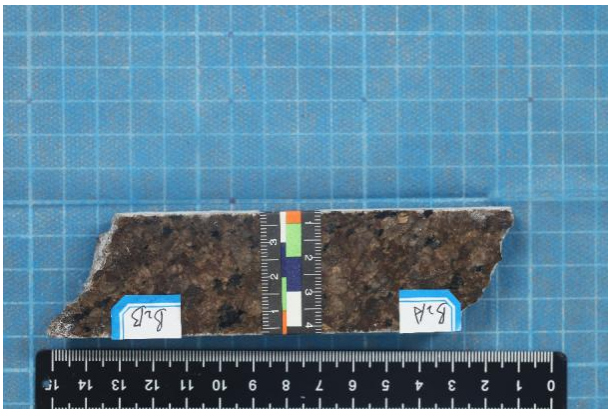


Fig. 3 The granite

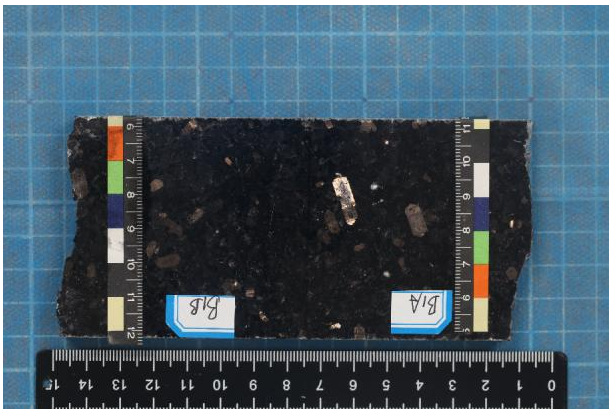


Fig.4 the effectmarble

3 RESULTS

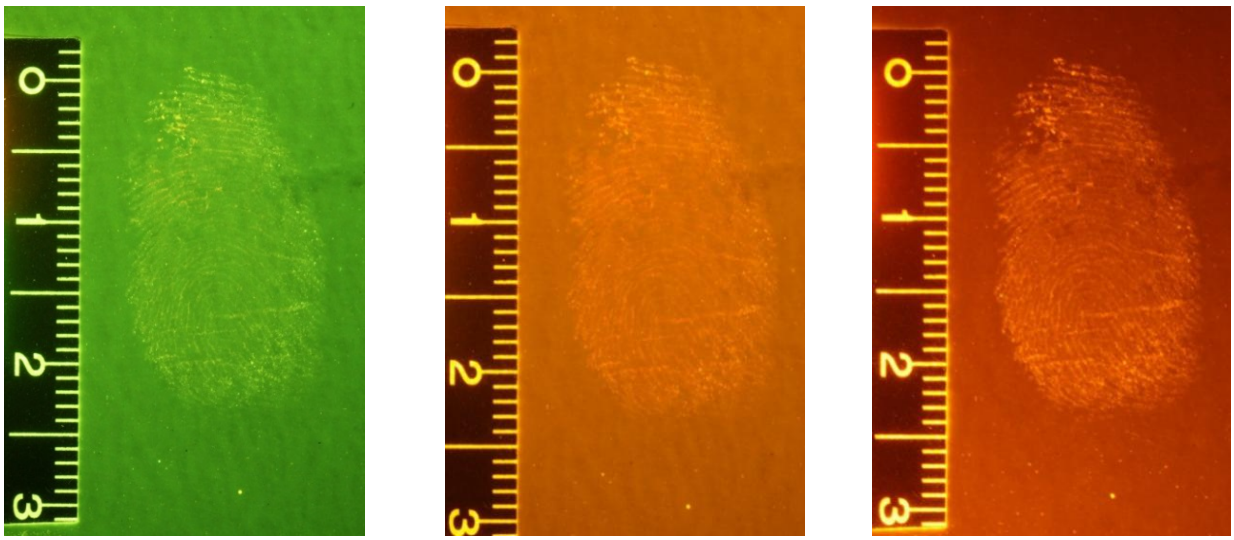
3.1 Sweat fingerprints on the white wall and laser directly show the effect

Under laser excitation, the fluorescence of the fingerprints of the three presses decreases in turn (see Figure 5 - 7).

The fingerprints of the first press can show complete fingerprints under the excitation of 445nm laser and 532nm laser. The 445nm laser can show the fingerprints well regardless of whether the 445nm laser uses a yellow filter or an orange filter (Figure 5).

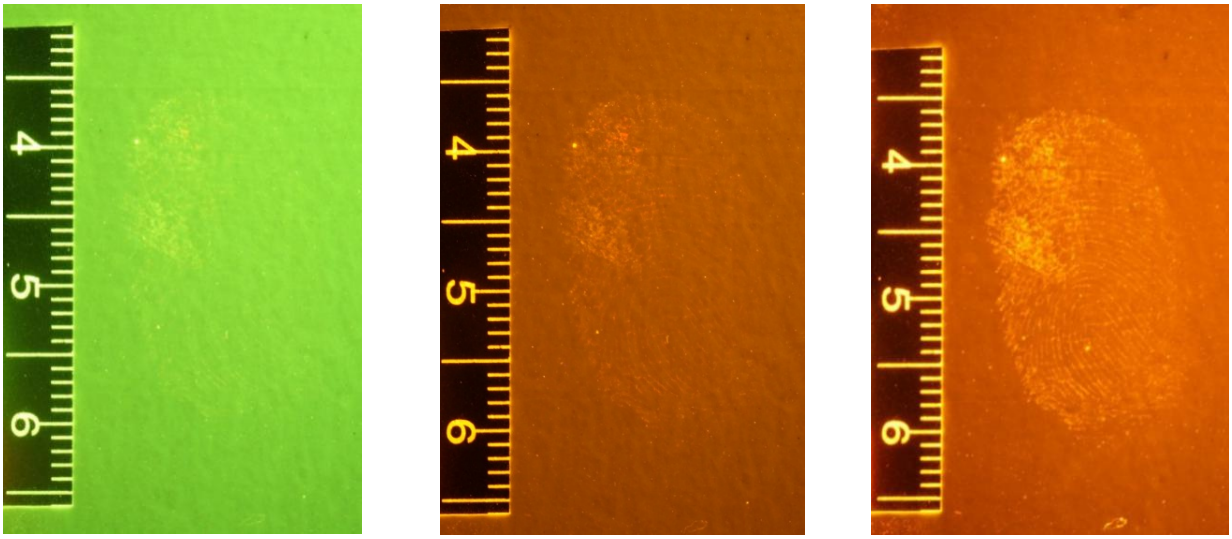
The fingerprint of the second press is directly displayed by a 445nm laser with a yellow filter and an orange filter, and only a small part of the detailed fingerprint lines can be obtained. The 532nm laser is equipped with an orange filter, although the overall fluorescence effect is better than that of the first display effect of the fingerprint is poor with one pressing, but most of the details of the lines are still well displayed (Figure 6).

For the third press of the fingerprint, the 445nm laser can only show faint traces of the fingerprint, while the 532nm laser equipped with an orange filter can still show most of the details of the fingerprint (Figure 7).



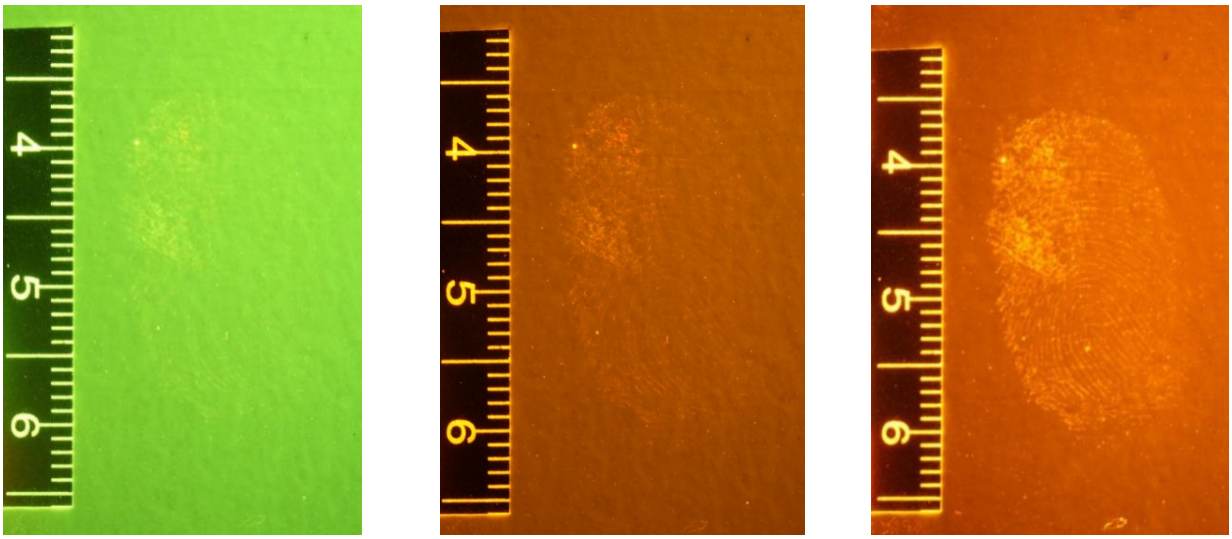
a. 445nm laser with yellow filter b. 532nm laser equipped with orange filter c. 532nm laser with orange filter

Fig. 5 Laser shows fingerprints after the first press



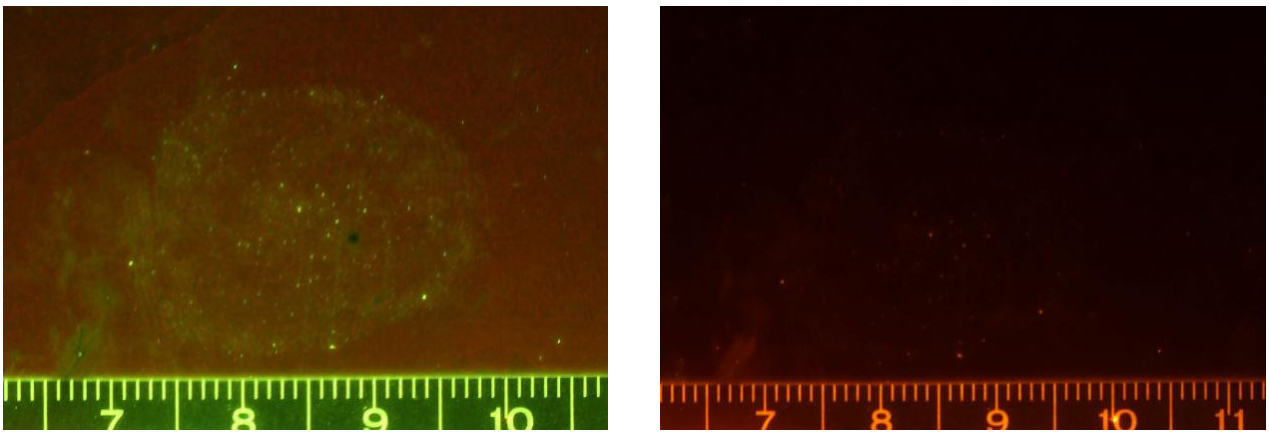
a. 445nm laser with yellow filter b. 532nm laser equipped with orange filter c. 532nm laser with orange filter

Fig. 6 Laser shows fingerprints after the second press



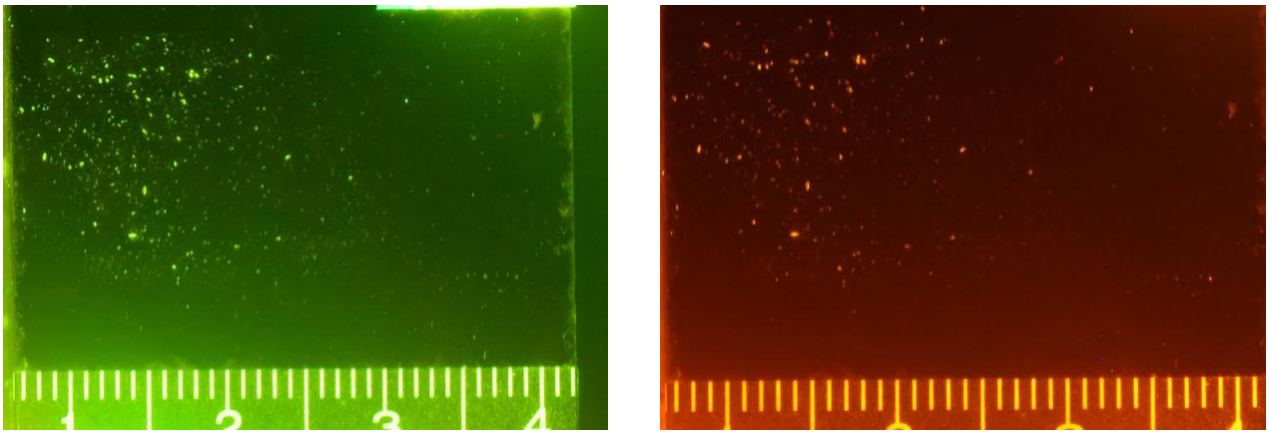
a. 445nm laser with yellow filter b. 532nm laser equipped with orange filter c. 532nm laser with orange filter

Fig. 7 Laser shows fingerprints after the third press



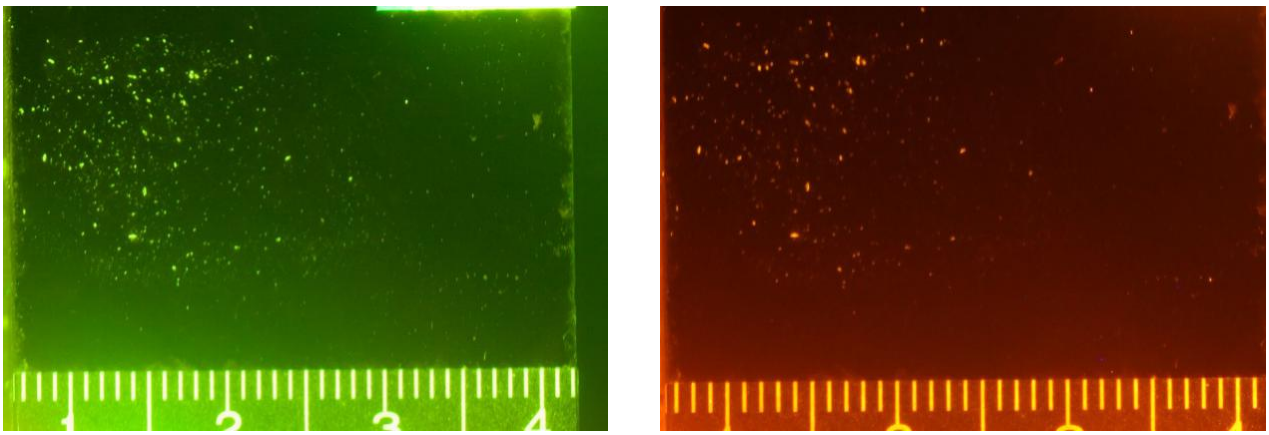
a. 445nm laser with yellow filter b. 532nm laser equipped with orange filter

Fig. 8 Laser shows fingerprints on white tiles



a. 445nm laser with yellow filter b. 532nm laser equipped with orange filter

Fig. 9 Laser shows fingerprints on granite



a. 445nm laser with yellow filter b. 532nm laser equipped with orange filter

Fig. 10 Laser shows fingerprints on marble

3.2 Laser display effect of sweat fingerprints on white tiles

Figure 8a shows the display effect of 445nm laser on white tiles. Although there are no clear fingerprint lines, you can still see obvious traces of sweat fingerprints on the white tiles. When the 532nm laser is used for visualization, there is almost no fluorescent signal of sweat fingerprints (Figure 8b).

3.3 Laser display effect on granite

The sweat fingerprints on the granite stone were

displayed by laser, and weak fingerprints were obtained. The results of the 445nm laser and 532nm are not much different (Figure 9).

3.4 Laser display effect on marble

It can be seen from Figure 10 that no effective sweat fingerprint trace fluorescence signal can be obtained on the marble, no matter under the irradiation of 445nm laser or 532nm laser, the laser has almost no effect on the appearance of sweat fingerprint on the marble.

4 DISCUSSION

In the process of on-site investigation and physical evidence inspection and identification, the laser display technology mainly uses the principle of laser excitation of fluorescence to realize the display of potential biological traces. In practical applications, the intensity of laser light is much higher than that of fluorescence, and a filter should be used to filter out the laser light so as not to affect the display effect. Under the premise of a certain laser irradiation power, the laser display effect is mainly related to two factors. One is the laser excitation wavelength. According to the Stokes shift principle, the fluorescence wavelength excited by the laser is longer than the excitation wavelength due to energy loss. When choosing a filter, generally choose a long-pass filter that can filter out the excitation light; on the other hand, it is the constituent substances of the guest and potential biological traces. Different substances absorb light differently, and the fluorescence spectrum is different from the substance composition. It is closely related and has certain specificity. The fluorescence spectrum of different substances is also different. Compared with the ordinary broad-spectrum light source, the width of the fluorescence spectrum is narrower, generally tens of nanometers.

Pressing sweat fingerprints on the white wall for the first time, using 445nm and 532nm lasers to directly visualize the fingerprints, both can get a better display effect of the fingerprints. But for the second and third times of pressing the fingerprint, the sweat is already less pressed at this time, and it can be seen that the direct effect of the 532nm laser is significantly better than that of the 445nm laser. When using a 445nm laser for visualization, a long-pass yellow filter and a long-pass orange filter were used, respectively, and when a 532nm laser was used for visualization, an orange filter was used. Because the white wall contains brightener, the brightener itself is a fluorescent substance, and it will also emit fluorescence under the excitation of 445nm laser. After passing through the filter, the fluorescence emitted by the white wall almost covers the fluorescence emitted by sweat fingerprints. Obvious traces are formed, and the change of the filter hardly affects the appearance of handprints. When excited by a 532nm laser, the fluorescence emitted by the white wall and the fluorescence emitted by the sweat fingerprints formed a significant difference in appearance. The change of the laser wavelength directly affected the appearance of the sweat fingerprints on the white wall. The fluorescent material in the white wall and sweat fingerprints, the difference in the fluorescence efficiency, fluorescence spectrum and other factors produced by different laser excitations leads to the difference in the final display effect.

For sweat fingerprints on white tiles, using 445nm laser excitation, we can observe obvious greenish sweat fingerprints under dark red background, but using 532nm laser excitation, there is almost no effective fluorescence signal. Compared with the display effect of sweat fingerprints on the white wall, the composition of sweat fingerprints is the same, but the object is different, and the difference of the objects directly affects the display effect of sweat fingerprints.

On granite, weak fingerprint fluorescence signals can be observed when excited by 445nm and 532nm lasers. On marble, neither the 445nm laser nor the 532nm laser can get an effective fluorescence signal of sweat fingerprints. There is a big difference in structure between granite and marble. The structure of granite is looser, while marble is denser. It can be inferred that the laser display effect is obviously related to the material composition and structure. Because laser excitation of fluorescence is an energy transfer process, the laser display effect may have a certain relationship with the internal energy transfer and conversion mechanism of the guest.

5 CONCLUSION

Different lasers produce different fluorescence effects, and there are obvious differences in fluorescence effects produced by different objects. This requires a preliminary understanding and grasp of the type, material composition, structure, etc. of the object in the investigation work, and make a preliminary judgment on the laser display effect of potential traces on the object. For the object suitable for direct laser display, select the appropriate laser to achieve the

best display effect. When the laser wavelength cannot be determined, you can switch between different wavelengths. To compare the display effect, and finally determine the appropriate laser wavelength. At the same time, the direct use of laser to visualize bio-fluorescence has a good display effect on biological traces with strong fluorescence characteristics, but it is difficult to achieve the display of biological traces with poor fluorescent effect, especially sweat fingerprints, which can be directly visualized by laser. The sweat fingerprint traces on this object are often difficult to obtain a good display effect. At this time, it is necessary to use the characteristics of the components contained in the sweat fingerprints to realize the display of the fingerprints with the help of specific fluorescent substances.

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Conflicts of interests